REMARKS

Applicants appreciate the thorough examination of the application that is reflected in the Office Action dated January 17, 2007. Applicants thank the Examiner for withdrawing the rejections of claims 1, 2-4, and 11-14 under 35 U.S.C. 102(e) as being anticipated by Numata et al., claims 5, 6 and 17 under 35 U.S.C. 103(a) as being unpatentable over Numata et al., claim 7 under 35 U.S.C. 103(a) as being unpatentable over Numata et al. in view of White et al., and claims 15 amd 18 under 35 U.S.C. 103(a) as being unpatentable over Numata et al. in view of Siegman et al. To expedite prosecution of this application, Applicants cancel claims 1-7, 10-15 and 17-18, and add new claims 21-30. After entry of the foregoing amendments, claims 21-30 (10 total claims; 2 independent claims) are pending in the application. Reconsideration of the application is respectfully requested in view of the above amendments and the following remarks.

Claim Rejection Under 35 U.S.C. 112, 2nd paragraph

The Office Action rejects claim 1 under 35 U.S.C. 112, 2nd paragraph as being indefinite.

Applicants submit that this rejection is moot in light of the cancellation of claim 1.

Accordingly, Applicants submit that the rejection of claim 1 under 35 U.S.C. 112, 2nd paragraph should be withdrawn.

Art-Based Rejections

Claims 1-7 and 10 and claims 11-15, 17 and 18

Claims 1-6 and 10 were rejected under 35 U.S.C. 103(a) as being unpatentable over Numata et al. in view of Krisvoshlykov et al., and claim 7 was rejected under 35 U.S.C. 103(a) as being unpatentable over Numata et al. in view of Krisvoshlykov et al. and further in view of White et al. Claims 11-14 and 17 were rejected under 35 U.S.C. 103(a) as being unpatentable over Numata et al. in view of Krisvoshlykov et al., and claims 15 and 18 were rejected under 35 U.S.C. 103(a) as being unpatentable over Numata et al. in view of Krisvoshlykov et al. and further in view of Siegman et al.

Applicants submit that this rejection is moot in light of the cancellation of claims 1-20.

Accordingly, for at least this reason, Applicants submit that this rejection should be withdrawn.

New Claims 21-30

As noted above, to expedite prosecution this application, Applicants cancel all of the pending claims, and submit new claims 21-30. Applicants submit the following remarks to point out some of the patentable features of the new claims and to preemptively address some of the Examiner's arguments presented in the Final Office Action.

New claim 21 relates to a system for transmitting data at a data rate of at least 10 gigabits per second by preferentially launching input power into a large core multimode fiber optic cable (LCMFOC) to increase a length/data rate product of the LCMFOC. This system comprises:

> a light source for transmitting data from a source as a first light signal, wherein the first light signal comprises a sequence of short light pulses at a data rate of at least 10 gigabytes per second;
>
> a lens having a focal length (f), placed in a path of said first light signal at a distance of approximately said focal length (f) from an end of said LCMFOC, wherein the lens is located to receive said first light signal from said light source and to collimate and focus said short light pulses onto the end of the LCMFOC such that a diameter of focused short light pulses is approximately equal to a core diameter of the LCMFOC to excite low fiber modes and minimize excitation of higher order fiber modes in the LCMFOC,
>
> wherein the LCMFOC is designed to decrease higher order fiber modes which increase pulse spreading that limit the length/data rate product and to thereby increase a transmission distance through the LCMFOC and output second light pulses which include substantially only lower order fiber modes, wherein the LCMFOC comprises:
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> > an exposed core having the core diameter which receives the focused short light pulses; and
> >
> > a selected doped cladding layer around said exposed core which is selected to excite low order fiber modes of the LCMFOC as said focused short light pulses propagate down the LCMFOC and to absorptively attenuate higher order fiber modes generated in said LCMFOC as said focused short light pulses propagate down the LCMFOC, such that: said focused short light pulses propagate through the LCMFOC with reduced short pulse spreading effects that limit a length/data rate product of said LCMFOC. (Emphasis added.)

Claim 26 relates to a method for transmitting data over a large core multimode fiber optic cable (LCMFOC) at a data rate of at least 10 gigabits per second. Claim 26 recites the steps of:

> providing a selected large core multimode fiber optic cable (LCMFOC), wherein the selected LCMFOC comprises: a doped cladding layer around an exposed core having a core diameter, wherein the doped cladding layer is selected to excite low order fiber modes of the selected LCMFOC and to absorptively attenuate higher order fiber modes of the selected LCMFOC which contribute to pulse spreading to increase a transmission distance through the selected LCMFOC; and
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> providing a source of short light pulses;
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> providing a lens of a focal length (f);
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> placing said lens in a path of between the source and the selected LCMFOC at a distance of approximately the focal length (f) from the source; and
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> transmitting data from said source as a sequence of short light pulses at a data rate of at least 10 gigabytes per second;
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> focusing the sequence of short light pulses with said lens to collimate and focus said short light pulses onto an end of the exposed core of the selected LCMFOC such that a diameter of focused short light pulses is approximately equal to the core diameter to produce a focused sequence of short light pulses to preferentially launch input power into said selected LCMFOC to excite low fiber modes and minimize excitation of higher order fiber modes in the selected LCMFOC to increase a length/data rate product of said selected LCMFOC,
>
> wherein the doped cladding layer:
>
> excites low order fiber modes as said focused short light pulses propagate down the selected LCMFOC; and
>
> attenuates higher order fiber modes as said focused short light pulses propagate down the selected LCMFOC so that said focused short light pulses propagate through the selected LCMFOC with reduced short pulse spreading effects that limit the length/data rate product of said selected LCMFOC, such that second light pulses output by said selected LCMFOC include substantially only lower order modes. (Emphasis added.)

Overview

In an embodiment of the high speed optical data transmission system, an input light signal is launched to large core multimode fiber optic cable to excite low order modes. The consequence of launching the power in low order modes for multimode fiber optic cable 200 is that a short pulse will propagate for a long distance with only minimal pulse spreading since the higher order modes are significant contributors to the spreading because of the longer distance they travel. A further benefit in reducing pulse spreading in large core multimode fiber optic cable is achieved by modifying cladding layer to attenuate higher order modes. As described in the present application, for example, with reference to FIGS. 4 and 5, Applicants ran experiments to verify that the length/data rate product of a large core multimode fiber optic cable could be significantly enhanced by launching a light signal to propagate low order modes while attenuating the higher order modes that affect pulse spreading. As discussed in the present application, the test results demonstrate that both initial launching of only lower order mode light and active attenuation of higher order modes contribute to increasing the length/data rate product of a large core multimode fiber optic cable.

For instance, with respect to the exemplary implementation shown in FIG. 3 of the present application, lens 303 collimates and focuses light signal 302 to launch mostly lower order modes into large core multimode fiber optic cable 305. Light signal 302 is collimated by lens 303 and focused having a diameter substantially equal to the core diameter d of large core multimode fiber optic cable 305 when placed a distance f from core 306. The output from lens 303 is a collimated and focused light signal 304. Collimated and focused light signal 304 is injected into the core of large core multimode fiber optic cable 305 and excites a minimal number of fiber modes, that is, modes with low values for l and m are produced. Hence, under these conditions the length/data rate product for large core multimode fiber optic cable 305 is maximized.

Applicants observed that the length/data rate product can be enhanced by selectively attenuating higher order modes without affecting the lower order modes. Large core multimode fiber optic cable 305 is modified to further attenuate the higher order modes thereby increasing the length/data rate product. In an embodiment of system 300, the modal discrimination of large core multimode fiber optic cable 305 is enhanced to damp the higher order modes that

contribute to pulse spreading. In general, a length/data rate product of large core multimode fiber optic cable 305 is increased by incorporating absorption loss such that the refractive index of a cladding layer 307 is complex. An example of a methodology to incorporate absorption loss is to dope cladding layer 307 with an absorptive material. Cladding layer 307 is doped to produce a small absorption level that selectively attenuates only higher order modes. To explain further, the lower order modes large core multimode fiber 305 will propagate with very low loss if the index of the core layer n_1 is primarily real (has a very low absorption coefficient). Since very little of the low order modes exist in cladding layer 307, such modes will only be minimally impacted by the absorptive material. At the same time substantial amounts of high order modes exist in the cladding, and consequently undergo significant attenuations. The absorptive material to dope cladding layer 307 is selected to minimize attenuation of lower order modes while sharply attenuating higher order modes most responsible for pulse spreading effects that limit the length/data rate product of large core multimode fiber optic cable 305.

Patentability of New Claims Over The Cited References

Numata et al. relates to an optical transmission system S_a in which a lens 112 converges an optical signal OS_{in} outputted from a light emission element 111. The optical signal OS_{in} having passed through the lens 112 enters a multi-mode fiber (MMF) 12. A vertex Z_0 of the lens 112 and an input plane F_{in} of the MMF 12 are at a distance Z_1. The distance Z_1 is set to a value which is not equal to the distance from the vertex Z_0 to the focal point Z_{fp} of the lens 112. As a result, a low-cost optical transmission system can be provided in which the influence of mode dispersion is reduced.

In Numata et al., the cladding 122 was composed of a polymer such as methacrylic resin (PMMA). See paragraph [0040] of Numata et al. Moreover, as discussed at paragraph [0060], Numata et al. discusses that: "Thus, the present optical transmission system S_a allows the influence of mode dispersion in the MMF 12 to be reduced based on the adjustment of the position Z_1, whereby the transmission bandwidth of the MMF 12 can be broadened. This eliminates the need for a mode separator 84 (see FIG. 13) in the optical transmission system S_a, unlike in the conventional optical transmission system S_{cv}." Numata et al. attempts to reduce the influence of mode dispersion in the MMF 12 by adjusting the position of Z_1 which in turn reduces the NA_{in}.

Applicants respectfully submit that the Numata et al. fails to teach or suggest, for example, the step of "transmitting data from said source as a sequence of short light pulses at a data rate of at least 10 gigabytes per second," as recited in claim 26. In the Final Office Action, the Examiner concedes that Numata fails to specifically disclose that "said light source transmits data at greater than 10 gigbits per second." In essence, the Examiner has asserted that this limitation is "well-known." Applicants respectfully disagree and to the extent the Examiner makes the same rejection with respect to any of the currently pending claims (e.g., claims 21, 23, 24, 26, 29, 30), Applicants will request that the Examiner provide an affidavit that supports such a rejection based on the official notice of the Examiner. Alternatively, in the event the Examiner seeks to maintain this ground of rejection, Applicants will request that the Examiner provide documentary evidence that these features would indeed be well-known. *See* MPEP 2144.03, 37 C.F.R. § 1.104 (d)(2), and *In re Lee*, 277 F.3d 1338, 1344-45, 61 U.S.P.Q.2d 1430, 1435 (Fed. Cir. 2002) (finding that reliance on "common knowledge and common sense" did not fulfill the PTO's obligation to cite references to support its conclusions as PTO must document its reasonings on the record to allow accountability and effective appellate review).

Applicants submit that the other cited references, including Krisvoshlykov et al., fail to cure the deficiencies of Numata et al. Applicants submit that new claim 26 is patentable since the cited references fail to teach or suggest at least these recitations of new claim 26.

In addition, Applicants respectfully submit that there is no motivation to combine the cited references. While Numata et al. observes that and that higher order modes are reduced to a minimum when the diameter of the light matches the diameter of the core, Numata et al. does not teach or suggest a doped cladding layer as claimed. That is, the Numata et al. fails to teach or suggest, for example, the step of providing a selected LCMFOC which comprises a doped cladding layer that "attenuates higher order fiber modes as said focused short light pulses propagate down the selected LCMFOC so that said focused short light pulses propagate through the selected LCMFOC with reduced short pulse spreading effects that limit the length/data rate product of said selected LCMFOC," as recited in claim 26. While Krisvoshlykov discloses a doped cladding layer, Applicants submit that **absent hindsight** gained from the teachings of the present application, there would be **no reason or motivation to combine these isolated teaching of the cited references in the manner that is recited in claim 26**. The

Krisvoshlykov patent relates to an active fiber amplifier or laser to be used as an optical source for a transmission system. By contrast, claim 26 relates to using a large core multimode fiber optic cable (LCMFOC) as a transmission system medium in a method for transmitting data over the large core multimode fiber optic cable (LCMFOC). Based on the Numata et al. and Krisvoshlykov references, nothing would suggest the desirability of modifying the system described in the Numata et al. reference to arrive at the **combination of** selecting a particular LCMFOC having a doped cladding layer "that is selected to excite low order fiber modes of the selected LCMFOC and to absorptively attenuate higher order fiber modes of the selected LCMFOC which contribute to pulse spreading to increase a transmission distance through the selected LCMFOC," and placing the lens in a particular location with respect to the LCMFOC "to preferentially launch input power into said selected LCMFOC to excite low fiber modes and minimize excitation of higher order fiber modes in the selected LCMFOC to increase a length/data rate product of said selected LCMFOC," as recited in claim 26. There is nothing in either reference which indicates that a reduction of higher order modes would result from the **combination** of these steps so that the signal output from the MMF 12 of Numata et al would include "substantially only lower order modes."

For reasons similar to those discussed above with respect to claim 1, Applicants submit that new independent claim 21 is also patentable over the cited references.

In conclusion, for the reasons given above, all claims now presently in the application are believed allowable and such allowance is respectfully requested. Should the Examiner have any questions or wish to further discuss this application, Applicants request that the Examiner contact the undersigned attorney at (480) 385-5060.

If for some reason Applicants have not requested a sufficient extension and/or have not paid a sufficient fee for this response and/or for the extension necessary to prevent abandonment on this application, please consider this as a request for an extension for the required time period and/or authorization to charge Deposit Account No. 50-2091 for any fee which may be due.

Respectfully submitted,

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